WORKING DRAFT

Technical Summary of Toll Analyses

Prepared for:
Washington State Department of Transportation
Urban Corridors Office

Prepared by:
Parsons Brinckerhoff
Parsons Brinckerhoff Quade & Douglas, Inc.
PB Consult Inc.
999 Third Avenue, Suite 2200
Seattle, WA 98104

Under Agreement # Y-8074

Washington State Department of Transportation

August 12, 2002

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

DISCLAIMER

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This Report summarizes several recent tolling studies conducted for WSDOT by various consultants including PB and was developed to assist in the current regional discussion of transportation funding. It is not a recommendation or proposal of WSDOT or PB. The Report, information contained herein including the work of other consultants, and any statements made within the Report, are all based upon information provided to PB by, and obtained from, WSDOT, the Puget Sound Regional Council (PSRC), and other sources. This information is subject to change and PB makes and provides no assurance as to the accuracy of any such information, nor bears any responsibility for any conclusions drawn from or actions taken on the basis of this Report.

The traffic and revenue results of the various toll analyses summarized herein are provided for feasibility considerations and to enlighten further policy discussions, and should not be construed as investment-grade projections. Better tools would need to be developed and applied with rigorous methods, including independent review of assumptions at every stage, to produce investment-grade projections suitable for securing a credit rating and obtaining toll revenue bond financing.

INTRODUCTION

The Central Puget Sound Region's transportation needs far exceed available funding, and increasing traffic congestion is adversely impacting the region's livability. This has led to a heightened call for new revenue sources to finance transportation infrastructure. User fees in the form of tolls have been a key element of this discussion, especially for the region's large scale "mega-projects." Technological advances in the area of electronic toll collection (ETC) have made roadway pricing more feasible by facilitating variable pricing to manage congestion while eliminating the traffic bottlenecks and land requirements of toll plazas. Tolling also has a key advantage over other transportation funding sources, in that it creates a direct linkage between project financing and those who use the roadway. Unlike a gas tax, the price of roadway use can be varied by facility, time of day, type of vehicle, and even vehicle occupancy. Given sufficient autonomy in setting prices, a toll road owner/operator has the unique ability to manage traffic flows, prevent congestion, and thus, assure the traveling public of an efficient and reliable route.

Senate Bill 6140, passed this year by the Washington State Legislature, permits the establishment of Regional Transportation Improvement Districts (RTIDs). An RTID is authorized to create and adopt a regional transportation investment plan providing for the selection, development, construction, and financing of transportation projects. The regional transportation investment plan is submitted to the voters within the RTID area for adoption. It may recommend, for example, the use of a variety of revenue sources, including tolls, to fund improvements (e.g., adding lanes to a highway of statewide significance).

Pursuant to SB 6140, the County Executives of King, Snohomish, and Pierce Counties proposed a RTID mechanism for generating local revenue to pay at least a portion of the costs for a list of regional projects. This plan was presented to each of the three county councils on May 1, 2002, and is expected to evolve into a ballot measure to take forward to the voters as early as Spring 2003. For each project, specific revenue sources and yields for the 10-year period from FY 2003-2012 were estimated. Put simply, the package indicated how much funding (for each project) the regional mechanism would provide under various levy rate assumptions. Five types of revenue were included as funding sources in the county executives' package:

- Sales tax;
- Vehicle licensing fees;
- Local option motor vehicle excise tax;
- Unused transit tax capacity (King County only); and
- Tolls

In the package, tolls are only used to help fund three "mega-projects" in King County: the Alaskan Way Viaduct replacement, Trans-Lake Washington (SR-520) improvements, and Interstate 405 (I-405) widening and improvements.

Previous toll discussions have focused on the traffic and revenue impacts of tolling a single facility — either from a managed lanes approach, whereby High Occupancy Vehicle (HOV) lanes or new capacity is priced, or as the entire roadway. In either case, the emphasis has been on revenue generation and demand management for the toll facility rather than on the impacts tolling may have on alternative highway and arterial routes. However, the traffic volume and revenue arising from one tolled route is related to whether or not adjacent or alternative routes are also priced.

Two natural questions arise from this line of thinking:

1) What happens to traffic demand on each facility if you toll all of the major highways within a given regional area?

2) What is the approximate range of potential toll revenue from system-wide tolling of major facilities, if tolls are set to balance revenue generation and network efficiency objectives?

To help answer these questions and provide decision-makers with better information regarding the toll revenue potential from widespread highway pricing, the Regional Toll Revenue Feasibility Study was commissioned by WSDOT. The objective of the study was to model a regional toll highway network, including those facilities slated for "mega-project" capital improvements, in order to identify the potential range of revenue that might result from widespread value pricing with the objective of optimizing overall network efficiency. The resulting revenue projections were intended to inform policy discussions and assist decision-makers in determining if tolling has sufficient revenue potential and /or is an appropriate congestion management tool to merit further research, modeling and analysis.

This summary provides an overview of the findings presented in the Regional Toll Revenue Feasibility Study, and encapsulates the individual tolling analyses completed to date on the Alaskan Way Viaduct, I-405, and SR-520. Please note that this summary is in many ways a work in progress; additional research will be needed to finalize the results presented herein.

BACKGROUND ON TOLLING

As discussed in the introduction, there are several mechanisms available to fund roads and transportation improvements. This study focuses on the applicability and effectiveness of tolls and, more specifically, value pricing to combat transportation gridlock in the Central Puget Sound Region. These mechanisms are described in more detail below. Furthermore, selected information about the historic use of tolls in the Pacific Northwest is presented, and examples are provided of national tolling projects that offer context for this analysis.

Toll Financing of Highway Facilities – History and Legislation

Tolls are one of the purest forms of user financing for road development. They are direct user fees charged for use of road capacity and services to the motorist. Historically, toll roads played a prominent role in the provision of road transportation in the eighteenth and nineteenth centuries. In fact, some research shows that in the first half of the nineteenth century, private toll roads outnumbered public roads in the United States (Meyer and Gomez-Ibanez, 1993). Private investors formed tollway companies that improved, constructed, and maintained roads and, in turn, charged the public for their use.[1]

In the late nineteenth century, toll road development tapered due to toll evasion and growing demand for faster rail travel. However, by the 1930s, some states began developing public toll road programs to respond to growth in automobile ownership, the rising needs of commerce, and the absence of significant federal aid for highways. While private tollway companies dominated the "turnpike" industry in the earlier centuries, U.S. toll facilities of the twentieth century have largely been authorized, constructed, and managed by quasi-public authorities established by state and local governments. The pursuit of toll roads declined again after 1956, when the Federal Highway Act established a federal gasoline tax to support the interstate highway system and prohibited tolling on new, federally-funded highways (23 U.S.C., Section 301).[2]

Today, public funding constraints have fueled new interest in tolls as a revenue source to support transportation investment. The current interest in toll roads is largely an outgrowth of provisions in the Intermodal Surface Transportation Efficiency Act (ISTEA; 1991) and the more recent National Highway System (NHS) Designation Act. Section 129(a) of US Code Title 23 sets forth the statutory requirements governing use of federal-aid highway funding for toll facilities. These provisions were significantly modified by the 1991 ISTEA and have been further amended by Section 313 of the NHS Designation Act.

Section 129(a)(1) establishes five broad categories of toll activities eligible for federal-aid highway funding:

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1 National Cooperative Highway Research Program: InnovativeFinance.org

2 Ibid.

1. Federal-aid funds may be used for the initial construction of toll highways, bridges or tunnels except on Interstate System routes. Federal funds may not participate in the initial construction of toll bridges or tunnels on the Interstate System.

2. Resurface, restoration, rehabilitation and reconstruction (4R) work on existing toll facilities [129(a)(1)(B)]. 4R work on existing toll facilities is eligible for federal participation regardless of whether or not the toll facility had in effect a prior Section 129 toll agreement with the Federal Highway Administration (FHWA).

3. Reconstruction or replacement of free bridges or tunnels and conversion to toll facilities [129(a)(1)(C)]. Examples of reconstruction would be widening existing bridges or tunnels to add lanes or providing a dual facility.

4. Reconstruction of free highways, except Interstate System, and conversion to toll facilities [129(a)(1)(D)]. Examples of reconstruction include adding new lanes to increase capacity, acquisition of access control coupled with construction of interchanges, or replacement of the full pavement structure.

5. Preliminary studies to determine the feasibility of the above toll construction activities [129(a)(1)(E)].

In addition, Section 1216(b) of the Transportation Equity Act for the 21st Century (TEA-21) established a new pilot program (Interstate Highway Reconstruction/Rehabilitation Pilot Program) to allow conversion of a free Interstate highway to a toll facility in conjunction with needed reconstruction or rehabilitation of the Interstate highway that is only possible with the collection of tolls.

The most recently toll-financed roads have primarily been new facilities on new alignments. Some examples include the Southern Connector, a 16-mile, $191 million toll road in Greenville, South Carolina; E-470, a 47-mile, $1.2 billion toll road near Denver, Colorado; and the San Joaquin, Foothill and Eastern Toll Roads, 67 miles of toll roads in Orange County, California, developed at a cost of $2.9 billion. The revenue sources for these projects vary, from those solely dependent on tolls, such as the Southern Connector, to the Orange County toll roads, which receive funding from development impact fees, to E-470 which receives funding from vehicle registration fees collected within the boundaries of the E-470 Public Highway Authority.

Value Pricing

Value pricing, also known as congestion pricing or peak-period pricing, entails fees or tolls for road use that vary by level of demand or congestion. Fees are typically assessed electronically to eliminate delays associated with manual toll collection facilities (i.e., an electronic sensor in the vehicle registers a variable toll rate against a prepaid account when the driver passes a toll point). This concept of assessing relatively higher prices for travel during peak periods is the same as that used in many other sectors of the economy to respond to peak-use demands. For example, airlines offer off-peak discounts, while a hotel room might cost more during peak tourist seasons. Similarly, road-use charges that vary with the level of congestion provide incentives to shift some peak-period trips to off-peak times, less-congested routes, or alternative modes. Furthermore, some lower-valued trips may be combined with other trips, or eliminated altogether. A relatively small shift in the proportion of peak-period trips can lead to substantial reductions in overall congestion and can improve travel times. In addition, while congestion charges create incentives for more efficient use of existing capacity, they also generate revenues that can be used to further enhance urban mobility.[3]

A number of value pricing projects have recently been launched in the United States. The private sector led the way in 1995 by constructing new tolled express lanes in the median of State Route 91 in Orange County, California. Tolls vary by time of day and level of congestion to maintain an uncongested alternative along one of the most heavily-traveled commuter routes in the United States. Under the Value Pricing Pilot Program and its predecessor, the Congestion Pricing Pilot Program established by ISTEA, value pricing projects have been launched in San Diego, California; Houston, Texas; and Lee County, Florida.

The California and Texas value pricing projects involve tolling on HOV lanes to make better use of available capacity. For example, in San Diego, California, drivers of single occupant vehicles are allowed to use the HOV lanes on Interstate 15 by paying a toll that varies directly with the level of congestion. In Houston, Texas, drivers of vehicles with two occupants can pay a fixed toll during rush hour to use an HOV lane on Interstate 10 that is otherwise restricted to vehicles with three or more occupants. A project in Lee County, Florida, involves the use of peak and off-peak toll variations to provide an incentive to shift travel out of the most heavily traveled time.[4]

In most cases, value pricing projects have involved managing lanes on existing facilities, though, as noted above, the SR-91 Express Lanes in California are newly constructed lanes in the median of an existing freeway. Additionally, the 407 Express Toll Route near Toronto is a newly constructed facility using variable pricing and 100% electronic tolling.

The variety of operating objectives that tolling and value pricing can target leads to a wide range of pricing strategies. Toll facilities may be operated to maximize revenue, to achieve a revenue target (perhaps linked to debt service and/or operating costs), to maximize travel benefits by minimizing overall network travel times, to maximize throughput of an individual facility, or to keep vehicle throughput within a target range. Just as different operating objectives suggest different toll structures, so does the availability and quality of alternate routes. The more a priced facility reduces delay and provides a reliable, efficient transportation connection over other alternatives, the greater the willingness to pay by the traveling public.

Brief History of Toll Use in Western Washington

SR-520 Floating Bridge Experience

The Governor Albert Rosellini Evergreen Point Floating Bridge (SR-520) opened in August 1963 with a $0.35 toll each way. The toll rate was set to pay debt service costs for construction bonds. In today's dollars, the $0.35 toll in each direction is equivalent to a real cost of $1.70. With

3 Federal Highway Administration Value Pricing Pilot Program brochure

4 Ibid.

projected inflation, this corresponds to $2.30 in 2014, the assumed year of implementation for regional tolling as modeled herein.

The SR-520 bridge toll — still at $0.35 per direction — was removed in June 1979. At the time of removal, the real cost of the toll had declined considerably since the bridge opening to about $0.85 in today's dollars (compared to cost of $1.70 in today's dollars at its opening), or $1.14 in year 2014 dollars.

In 1978, the last full year of toll operations, annual average daily traffic numbered 60,452 vehicles, versus 56,752 on the un-priced parallel I-90 floating bridge. By 1980, traffic on SR-520 had jumped 19.3% to 72,139, while traffic on I-90 fell by 7.9% to 52,283. Since underlying traffic growth was negligible during this period, these results suggest that toll diversion on SR-520 was approximately 16.2%, with over one-third of the toll-inhibited vehicle trips diverted to I-90, and the remainder either traveling north around the lake or not at all.

Hood Canal Bridge Experience

The $2.00 toll on the Hood Canal Bridge was removed on August 29, 1985. In 1984, annual average daily traffic was 5,982 vehicles with the toll. In 1986, that number jumped 38% to 8,253 vehicles in the first full year without the toll. This seems to indicate that in the year before the toll was eliminated, it was causing a diversion of 27.5% of would-be vehicle trips to alternative routes, or more likely in this case, to not be made at all.

National Experience

The following table provides some comparable information for selected toll facilities in the U.S. for purposes of illustrating the context of implementing tolls in the Central Puget Sound Region. While the list is by no means comprehensive, it does give an indication of a range of toll rates, revenue streams, and development costs for different facilities. Actual revenue for different facilities can vary greatly based on a number of factors, including the operating objective, configuration of the facility, number of trucks and toll rate, and the types of markets served.

Additional information on these and other comparable North American toll facilities can be found in the Regional Toll Revenue Feasibility Study.

Table 1
Toll Rate & Revenue Information for Selected North American Facilities

	91 Express Lanes	Dulles Greenway	Harris County Toll Road	E-470	Southern Connector	San Joaquin Toll Road	Foothill and Eastern Toll Roads
Location	Orange County, CA	Northern Virginia	Houston, Texas	Denver, CO	Greenville, SC	Orange County, CA	Orange County, CA
Year Opened	1995	1995	1987	1998	2001	1996	1993–1999
Length (miles)	10	14	83	46	16	15	36
Toll Range (automobile)	$1.00 to $4.75	$0.50 to $2.00	$0.25 to $2.00	$0.50 to $5.75	$0.50 to $1.50	$2.50	$0.50 to $4.50
Toll Rate per Mile	$0.10 to $0.48 (value-priced)	$0.14	$0.06 to $0.13	$0.15	$0.09	$0.17	$0.13 to $0.23
Toll Revenue per year	$21.3 M	$19.8 M	$142.3 M	$23.2 M	$2.6 M	$59.3 M	$78.3 M
Annual Vehicle Trips	7.7 M	14.4 M	140.0 M	N/A	3.5 M	38.0 M	32.0 M
Revenue per Mile	$2.1 M	$1.4 M	$1.7 M	$0.5 M	$0.2 M	$4.0M	$1.5M
Revenue per Trip	$2.77	$1.38	$1.02	N/A	$0.75	$1.56	$2.45
Development Cost	$130 M	$350 M	$1.0 B	$1.2 B	$191 M	$800 M	$965 M
Development Cost per Mile	$13.2 M	$25.0 M	$12.4 M	$25.5 M	$12.0 M	$53.3 M	$26.8 M

METHODOLOGY AND ANALYSIS

This section provides an overview of the transportation modeling work that has already been completed in the Central Puget Sound Region, identifies the geographic focus and transportation corridors analyzed in the Regional Toll Revenue Feasibility Study, and explains the methodologies used to perform the analyses.

Recent WSDOT examinations of value pricing have ranged from individual analyses of three specific "mega-projects" to an examination of a regional toll network reflecting a 131 mile system of multiple limited-access facilities in the Central Puget Sound area. The methodology summary herein applies to the latter regional toll network analysis, though the same methods were applied in varying degrees to the individual toll facility analyses.

Individual Toll Facility Analyses

For the **Alaskan Way Viaduct**, a toll feasibility study was recently completed. The first round of this work indicates that while tolling is feasible, the demand characteristics of this relatively short roadway, combined with the availability of un-priced alternative routes, limit the revenue potential of the Alaskan Way Viaduct as a stand-alone toll facility.

Examinations of value pricing have also been performed for the **I-405 Corridor Program**, though the toll modeling work completed to date has focused primarily on high occupancy toll (HOT) and managed lanes concepts — whereby single occupant vehicles (SOVs) are allowed to purchase excess managed lane capacity during peak periods — as opposed to the tolling of all lanes of the facility.

Toll revenue projections for an independent **SR-520 Trans-Lake Washington Project** were also recently completed. The Trans-Lake Washington Project team modeled several tolling scenarios, and estimated toll revenue for a six-lane SR-520 scenario that excluded tolls on I-90.

Regional Toll Network Analysis

Table 2 lists the seven facilities that were analyzed in this regional pricing exercise, totaling 131 miles of limited access highways in King and South Snohomish Counties. Five of the seven facilities are proposed for capital improvements, including replacing the earthquake-damaged State Route 99 (SR-99) Alaskan Way Viaduct, completing the south extension of SR-509, and adding person-carrying capacity to SR-520, I-405, and a portion of SR-167. Only Interstate 5 (I-5) and I-90 are not being considered for major capital investments within the toll network boundaries (although they will benefit from the other improvements). A limited access extension of SR-99 from Spokane Street south to the First Avenue South Bridge and connecting with State Route 509 (SR-509) was also included in the future network modeled. The assumed year of completion of the toll network and full implementation of tolling was 2014.

Table 2
Regional Toll Network Facilities

Toll Facility	*Extent of Tolling (North to South)*	*Toll Distance (miles)*
SR-99 / AWV	Roy St. to 1st Ave S.	6.1
SR-509	1st Ave S to I-5 at SR-516 I/C	11.8
I-5	North I-405 I/C to Pierce Co.	43.1
I-405	Entire Length	30.2
SR-167	I-405 to Pierce Co.	14.1
I-90	I-5 to SR-900	13.3
SR-520	Entire Length	12.8
Entire Central Puget Sound Network		131.3

Analysis Methodology

WSDOT's examination of value pricing for the various Central Puget Sound Region highways, including the proposed "mega-projects," was supported by the ready availability of a value pricing analysis methodology developed by ECONorthwest for use with the PSRC Regional Travel Demand Model.[5] In theory, the mechanism by which tolls are simulated within the regional model is relatively simple. On an un-priced roadway, users consider only their own travel time costs, and not the delay costs that their vehicle imposes on other users. This behavior tends to result in roadway over-consumption and congestion, especially during peak demand times. Optimal travel behavior — that which theoretically minimizes overall network travel time — could be induced by applying tolls that are equivalent to the incremental delay imposed on others, with the revenues used to make cost-beneficial transportation investments. This is referred to as the "economically efficient" toll.

Within the Central Puget Sound Region, PSRC explored value pricing at a region-wide level as part of the long-range Metropolitan Transportation Plan update. PSRC examined value pricing (tolling to manage traffic flow) with an operating objective of approximating the optimal economically efficient toll. The PSRC's regional travel demand model and forecasting procedures were adapted for analyzing value pricing within the region. While these tools represent the best methods available for this analysis, they are limited in two key ways: (1) this work comes close to exceeding the intended application of the models, and (2) the timing is

[5] *Transportation Pricing Alternatives Study — Technical Memorandum 3: Simulating Congestion Pricing in EMME/2*, prepared for the Puget Sound Regional Council. ECONorthwest, 2000.

such that this effort does not benefit from work-in-progress improvements to the regional model.

The modeling approach employed seeks to internalize the external time cost or incremental delay that an additional vehicle imposes on all other vehicles in the traffic stream. When users are compelled to consider this additional cost, some users alter their travel behavior, resulting in lower highway volumes and higher speeds. As roadway demand increases, the economically efficient or optimal toll also rises at an increasing rate to maintain reasonable speed and flow conditions. This happens by inducing a sufficient number of would-be road users to seek alternative routes, modes, or times to travel.

Optimal toll rates, expressed in time costs as minutes per mile, are derived from the model results – based upon the volumes and volume-to-capacity ratios for each roadway link in the model. Toll rates are aggregated to analysis segments and calculated by time period (AM peak, PM peak, and midday/evening off-peak) and direction of travel over a 15-hour portion of the day. The resulting toll time costs are then converted to monetary units by applying the average willingness to pay for delay reduction, expressed in dollars per hour. Research has shown that this value of time is approximately one-half of the average wage rate. For purposes of these analyses, the value of time was varied between one-third and one-half of the average wage rate for King County to create a range of monetary toll rates. The toll rates are expressed in inflated dollars escalated to the year of collection, and apply to single and two-occupant vehicles. Three-plus occupant vehicles and transit vehicles are assumed to use HOV lanes at no charge or would otherwise be exempted from tolls. Trucks are tolled at a multiplier of the auto toll rates.

Tolls are assumed to be levied electronically throughout the regional toll network. The AM and PM peak periods would vary in timing and duration by facility and location, but in no cases are they less than three hours. Peak toll rates would vary noticeably by facility conditions, levels of congestion, and location to remain at their optimal levels. With reduced facility demand, the off-peak toll rates are generally lower. Off-peak tolls would apply to a midday window of time on weekdays, weekday evenings from 7 – 9 PM, and weekends from 6 AM – 9 PM. The network was assumed to be toll-free every day from 9 PM – 6 AM, both to give users an un-priced choice of travel, and also because, in most cases, traffic volumes are not high enough to generate optimal toll rates much above zero.

Application of the toll modeling methodology within the PSRC regional model results in modified traffic forecasts of vehicular travel within the general purpose lanes, and allows for the calculation of the optimal toll rates per mile by time period and analysis segment. Transit vehicles and 3+ HOVs using the toll-free HOV lanes are excluded from these traffic forecasts.

Introduction of optimal tolls on limited access highways in King and South Snohomish Counties will result in the diversion of some vehicle trips away from these facilities during the toll periods. These diverted trips fall into several categories:

- Travelers who make the same trip but divert to an alternate, un-priced route, usually another highway or arterial street;
- Travelers who continue to make the same trip on the tolled facility using their private vehicle, but traveling at a different time of day, when there would be a lower toll rate;

- Travelers who continue to make the same trip at the same time of day, but who will now travel in a vehicle that can use toll-free HOV lanes, either in a high occupancy vehicle with three or more occupants or in a bus;
- Travelers who will choose to change their trip behavior, either traveling to a different destination, such as one in a different direction that they can get to without using a tolled highway, or one nearer to their origin so that the shorter distance results in a lower toll charge to get there; and
- Travelers who opt to eliminate trips, either by not traveling at all, or by combining the functions of two or more trips into a single trip.

The model processes for determining diversion, interpretation of the resulting diversion rates, and the impacts on the arterial system warrant further research and analysis. The regional travel demand model does an adequate job of estimating the overall levels of diversion, but it is less able to provide reasonable estimates of what would become of the diverted vehicles, particularly for diversion to arterial streets. The model is most able to estimate diversions to other routes and modes, and is least able to estimate diversions to other time periods or eliminations of trips.[6] Moreover, the model may not sufficiently discourage arterial street use as an alternative to a tolled highway as the arterials get congested. All of these factors suggest diversion may be over-estimated, which would result in both underestimated optimal toll rates and toll facility traffic volumes — both of which would tend to underestimate the revenue yield.

Nonetheless, examining the 2030 traffic forecast with and without tolls indicates that, at least on a daily basis, total vehicle miles traveled on the arterial system would not increase with the presence of tolls on the limited access facilities. However, there are bound to be individual arterial segments that would be loaded with increased traffic at certain times.

The model-derived optimal toll rates were applied to the toll traffic volumes, expressed as vehicle miles traveled by analysis segment, to generated weekday revenue projections by direction and time period. A series of adjustments and factors were then applied to yield annual traffic projections. These include weekday-to-weekend day factors, weekday and weekend truck percentages to facilitate trucks paying a multiplier of the auto toll, and a five percent reduction to the overall volumes to reflect the potential for lost revenue from non-participation and/or evasion.

A range of toll revenues were projected for the regional toll network from the year of implementation (2014) through the model forecast horizon (2030).[7] These forecasts represent potential gross revenues before any operations, maintenance and administration costs. The "high end" of the revenue spectrum is determined using the base value of time of one-half the average wage rate to derive the optimal toll rates, combined with the assumptions of weekend tolling at the off-peak toll rates and the tolling of trucks at an average toll rate of three times that paid by passenger vehicles. In this case, the term "high end" represents the top of the regional tolling revenue range for the given assumptions under the economically efficient toll methodology; it is not meant to convey the point of revenue maximization, and is in all

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6 Overall network demand remains relatively fixed in the regional model, which may not be a reasonable if trips are eliminated.

7 For purposes of this exercise, it is assumed that all of the proposed network improvements, including a limited access connection between the Alaskan Way Viaduct and SR-509, would be in place by 2014.

likelihood below this point. The "low end" of the spectrum applies conservative assumptions, including the low value of time of one-third the average wage rate, an average truck toll rate of two times the auto rate, and no tolling on weekends.

It should be noted that nominal annual revenue is assumed to grow at an increasing rate over time. This reflects both growing demand and a rising set of optimal toll rates on the regional facilities, the latter which are assumed to escalate for two reasons:

1. Growth in traffic demand will necessitate an increasingly higher optimal toll in order to elicit the appropriate travel behavior changes and diversion to maintain economically efficient network travel conditions and speeds; and

2. Over time, general inflation will increase the average wage rate, and thus users' value of time, the latter of which drives the calculation of the optimal toll rate to keep up with inflation.

This is an important outcome, and one that may prove challenging due to public resistance even after tolling is implemented. Failure to increase optimal toll rates for both value of time inflation and rising demand, particularly during peak periods, would eventually lead to the recurrence of congestion. Moreover, because value of time is variable, and may on the margin increase substantially over average values, it may be advisable to craft toll enabling legislation in such a way that allows the toll authority to set the lowest toll that keeps speeds no lower than some threshold. The value for this threshold would be determined in advance based upon the facility characteristics and desired operating objectives.

The methods employed provide ranges for economically efficient or optimal tolls that attempt to minimize overall network travel times, which most likely results in toll rates below those that maximize revenue, but above those that pack the facilities for maximum throughput. However, these methods do not indicate where in this spectrum the toll rates lie, nor do they give any indication of the elasticity of demand. As such, there is no way to pin down how much demand and revenue will change if the optimal toll rates are altered. Indeed, a much more comprehensive modeling effort, involving substantial market survey research and independent review of all modeling assumptions, would be required to produce investment-grade toll traffic and revenue forecasts. Nonetheless, the resulting range of annual revenues likely encompasses some portion of the true revenue potential, and can thus help decision-makers ascertain if additional, more resource-intensive market research and modeling are warranted.

TOLL ANALYSIS RESULTS

The following presents the revenue and related results for the individual toll facility analyses as well as for the regional toll network study based upon the work to-date. All of the revenue estimates apply to year 2014 demand conditions and are expressed in year 2014 dollars. Cost estimates for various facility improvements, where provided, are expressed in dollars of the mid-point of construction year.

SR-99: Alaskan Way Viaduct

Description/Assumptions

Four alternatives are currently under investigation for replacing the Alaskan Way Viaduct. All include the construction of a new six-lane facility between S. Spokane Street and Roy Street. The four alternatives differ as described below:

- The aerial structure alternative would construct a new, elevated structure between South King Street and Battery Street, connecting via a new tunnel under Bell Street to Aurora Avenue North. Estimated cost: $5.7 to $6.4 billion.
- The aerial and tunnel alternative would construct a new elevated structure for northbound traffic and a tunnel for southbound traffic between South Holgate Street and Battery Street, connecting via a new tunnel from Battery Street to Aurora Avenue North. Estimated cost: $7.8 to $8.9 billion.
- The tunnel alternative would construct a new tunnel from South King Street to Aurora Avenue North. Estimated cost: $10.1 to $11.6 billion.
- The extended tunnel alternative would construct a new tunnel from South King Street to Aurora Avenue North, via Broad Street. Estimated cost: $8.8 to $10.3 billion.

Individual Facility Revenue

The SR-99: Alaskan Way Viaduct Project Toll Feasibility Study estimated toll revenues on a new SR-99 facility (extended tunnel alternative) from South Spokane Street to Roy Street. This estimate assumed that no other facilities in the region would be tolled. Estimated toll revenues for the SR-99 project from South Spokane Street to Roy Street depend on the assumptions for the value of time and weekend tolling, and would range from:

- $6 to $9 million per year (2014)

Revenue within a Regional Toll Network

The Regional Toll Revenue Feasibility Study estimated toll revenues on SR-99 (extended tunnel alternative) as part of a regional system of toll facilities. The system included tolling on SR-99 from the First Avenue South Bridge to Roy Street (including a tolled, limited access SR-99 facility from the First Avenue South Bridge to South Spokane Street) and an extended SR-509, with the two facilities forming a west corridor alternative to I-5. The estimated year 2014 annual revenue potential of tolling a 6-lane SR-99, from South Spokane Street to Roy Street, as part of a regional value pricing system, depend on the assumptions for the value of time, truck toll multiplier and weekend tolling, and would range from:

- $6 to $11 million per year (2014)

Including the full length of SR-99 modeled as a toll facility — from the First Avenue South Bridge to Roy Street — estimated toll revenues would be in the range of:

- $8 to $15 million per year (2014).

I-405 / SR-167

Description/Assumptions

The I-405 Corridor Program, including improvements to SR-167 between I-405 and South 160th Street, will add two new lanes in each direction on I-405 (and one lane in each direction on the northern portion of SR-167) plus truck climbing lanes where needed. The program also includes a new bus rapid transit system, HOV ramps and park and ride lots throughout the corridor and new and widened arterials within the study area.

Estimated cost for the program ranges from $9.1 to $10.9 billion.

Individual Facility Revenue

An estimate has been made by the I-405 Corridor Program team of the revenue potential of operating four lanes on I-405 (two in each direction) as HOT or managed lanes, allowing SOVs to "buy in" when there is excess capacity not used by 2+ HOVs. The remaining lanes of I-405 were assumed to be toll-free, and no other facilities in the region were assumed to be tolled. This estimate was made using a different methodology than that used for the other revenue estimates presented in this report, and should be considered preliminary.

The estimate was made for year 2020 conditions, with toll rates varying from 10¢ to 40¢ per mile. Converting to year 2014 conditions and dollars (using trend data prepared as part of the Regional Toll Revenue Feasibility Study) yields an estimate of annual revenue potential of:

- $20 to $40 million per year (2014).

No HOT/managed lane revenue estimates were prepared for SR-167 as part of the I-405 Corridor Program.

Revenue within a Regional Toll Network

Revenue estimates for I-405 as part of a regional value pricing system were prepared as part of the Regional Toll Revenue Feasibility Study. Assuming tolling of all lanes on I-405 except for a single 3+ HOV lane in each direction, annual revenue depends on the assumptions for the value of time, truck toll multiplier and weekend tolling, and would range from:

- $64 to $119 million per year (2014).

Estimated toll revenues for SR-167 from I-405 to the Pierce County line range from:

- $18 to $33 million per year (2014).

The northern portion of SR-167 where most of the improvements are expected is estimated to contribute approximately $5 to $10 million per year out of the above range.

SR-520: Trans-Lake Washington

Description/Assumptions

Three alternatives are currently under investigation by the Trans-Lake Washington Project team. These include:

- A safety and preservation alternative, which would rebuild the existing freeway between Seattle and Redmond, where needed, including replacement of the floating bridge, its approaches and the Portage Bay viaduct, along with the addition of expanded roadway shoulders and bicycle and pedestrian lanes. Estimated cost: $1.8 to $2.1 billion.

- A 6-lane alternative, which would reconstruct and expand SR-520 to 6 lanes (two general purpose lanes and one HOV lane in each direction) between Seattle and Redmond. Estimated cost: $4.9 to $5.9 billion.

- An 8-lane alternative, which would reconstruct and expand SR-520 to 8 lanes (three general purpose lanes and one HOV lane in each direction) between Seattle and Redmond. Estimated cost: $6.0 to $7.4 billion.

Individual Facility Revenue

Several toll scenarios were modeled to assess demand for the above three alternatives, and toll revenues were estimated specifically for the 6-lane alternative over the entire 12.8 mile length of SR-520, assuming no tolls on I-90. These revenue estimates were developed using a streamlined approach of the economically efficient toll methods employed in the Regional Toll Revenue Feasibility Study, and as such, they rely on some of the toll assumptions and results of this latter work.

The potential range of annual revenue for SR-520 as a stand-alone toll facility is:

- $18 to $31 million per year (2014).

Revenue within a Regional Toll Network

Revenue estimates for SR-520 from I-5 to its end in Redmond were prepared as part of the Regional Toll Revenue Feasibility Study's examination of a toll network. Revenue estimates for a tolled 6-Lane SR-520, as part of a regional value pricing system that includes tolling on I-90, would be in the range of:

- $23 to $40 million per year (2014).

SR-509

Description/Assumptions

The project will complete SR-509 as a six-lane freeway (two general purpose and one HOV lane per direction), between I-5 and South 188th Street in SeaTac. It also adds new lanes (portions of which are collector/distributor lanes) on I-5 from South 320th Street to South 200th Street, improves interchanges on I-5, and completes the South Access Expressway to the Sea-Tac International Airport.

Estimated cost ranges for the project are from $0.9 to $1.0 billion.

Individual Facility Revenue

Toll revenue projections for an independent SR-509 project have not been prepared.

Revenue within a Regional Toll Network

The Regional Toll Revenue Feasibility Study estimated toll revenues on SR-509 as part of a regional system of toll facilities. The system included tolling on SR-509 from I-5 to the First Avenue South Bridge. For modeling purposes, it was assumed that an HOV lane in each direction would be completed on the existing portion of SR-509 to match the new southern extension, and that SR-509 would connect to a tolled limited access SR-99 facility from the First Avenue South Bridge to South Spokane Street, where it would join with a tolled Alaskan Way Viaduct replacement facility north to Roy Street. The entire tolled portion of SR-99 was assumed to be three lanes in each direction with no HOV lanes.

The estimated toll revenues for the full length of SR-509 from I-5 to the First Avenue South Bridge, would be in the range of:

- $11 to $20 million per year (2014).

The southern portion of SR-509 from I-5 to SR-518, where the new roadway and most of the associated improvements are focused, would be expected to contribute in the range of $5 to $9 million per year out of the above revenue for the entire facility.

Description/Assumptions

It was assumed that all major limited access facilities in King and the southernmost portion of Snohomish County — a network of 131 miles as identified earlier in Table 2 — would be tolled between the hours of 6AM and 9PM.

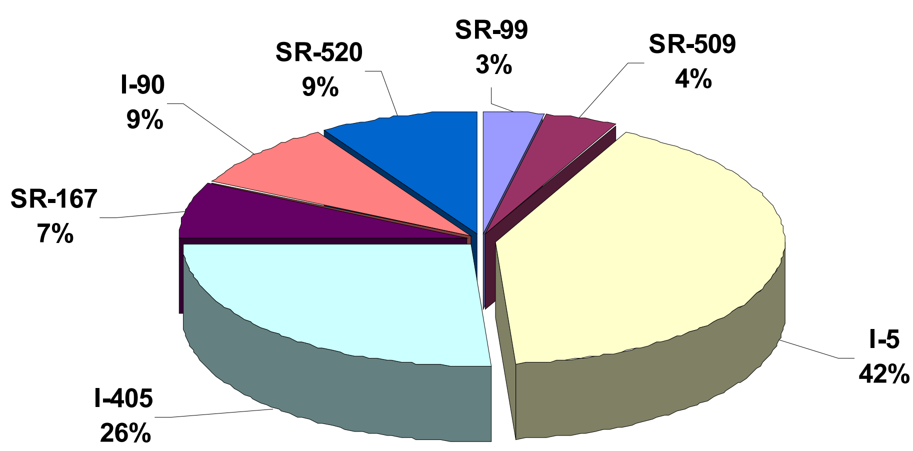
Revenue

Table 3 presents each facility's contribution to the projected regional toll network revenue for the year 2014, in 2014 dollars. Figure 1 shows the distribution of revenue by facility.

Table 3
2014 Projected Regional Toll Revenue Range in Inflated Dollars

Toll Facility	*Toll Distance*	*2014 Revenue Range in Inflated Dollars*	
		LOW END: Low Value of Time Weekends Toll-Free 2x Truck Toll Factor	*HIGH END: Base Value of Time Weekend Tolling 3x Truck Toll Factor*
SR-99	6.1	$8.5 M	$14.8 M
SR-509	11.8	$11.5 M	$20.1 M
I-5	43.1	$102.8 M	$189.2 M
I-405	30.2	$64.4 M	$119.0 M
SR-167	14.1	$17.9 M	$32.5 M
I-90	13.3	$24.1 M	$41.8 M
SR-520	12.8	$23.0 M	$40.0 M
Network	**131.3**	**$252.1 M**	**$457.3 M**

Figure 1
2014 Distribution of Regional Toll Revenue by Facility



SUMMARY OF FINDINGS

- The Regional Toll Revenue Feasibility Study suggests that a regional toll network could generate toll revenues in 2014 within the range of approximately $252 to $457 million per year in inflated dollars, depending on the underlying value of time assumption and various operating parameters, and before operating and maintenance expenses. This estimated annual range is expected to grow to between $535 and $955 million by 2030, assuming tolls escalate with demand growth and inflation.

- Travel levels on the highway network of King and South Snohomish Counties have reached critical levels relative to available capacity. This makes value pricing of this capacity a viable method to manage demand to prevent congestion and generate new revenue to fund transportation improvements.

- Simulating economically efficient tolls in the regional travel demand model for seven major highway facilities in the regional network yields optimal toll rates that seek to *minimize overall network travel time (maximize travel benefits)*. These toll rates are higher than those that would *maximize individual facility throughput* but lower than those which would *maximize toll revenue*.

- In the assumed year of implementation (2014), the optimal regional network toll rates range from 4 cents to 42 cents per mile in year of collection dollars, depending on the location, time of day, and travel direction.

- At the time of writing, general tolling of federally funded interstate highways is highly restricted. Implementation of any regional tolling concept would likely require that these restrictions be relaxed. There is some indication that this may occur in the next federal transportation funding authorization act.

- Implementation of tolls will cause travel demand on these facilities to decrease for users whose cost of travel (time plus tolls) exceeds the benefits of travel, and these users will seek other options, including different travel modes, travel at different times of day or on different facilities, travel to different destinations, trip consolidation, and trip elimination.

- Additional policy and institutional factors need further consideration.

NEXT STEPS

Optimal toll rate estimates and revenue forecasts in the toll analyses to-date represent initial or planning stage results, and are intended to inform decision-makers considering myriad infrastructure investments and possible funding sources. A number of possible next steps could be undertaken, assuming that the preliminary revenue results and public momentum look sufficiently promising to warrant further consideration of region-wide or facility-specific tolling:

- **Perform Additional Research.** Additional toll research, modeling, and revenue estimation work should be considered, ranging from additional modeling, sensitivity testing and assumptions refinement to a much more involved process yielding "investment grade" traffic and toll revenue forecasts.

- **Identify Operating Objectives.** As part of the refinement of the traffic and revenue forecasts, consideration needs to be given to the operating objectives of tolling. In other words, we must clarify whether the objective is to maximize revenue by creating relatively substantial time savings benefits for those most willing to pay, or to generate less revenue while maximizing network travel benefits by minimizing the collective travel time of all users.

- **Examine Toll Collection Methodology.** More attention should be directed to the technological and policy considerations of electronic toll collection, especially with consideration of a regional toll network. This effort should include an in-depth look at the toll collection capital investments, technology application, and ongoing operations, maintenance and administration costs. This work could be done independently of any toll modeling and revenue refinement, as long as both shared the same set of operating assumptions so as to not affect the revenue projections. As an element of the design process, the toll collection capital and ongoing operations cost estimation effort should be subjected to the WSDOT Cost Estimation and Validation Process (CEVP).

- **Review Compatibility of Existing Policies and Laws.** Additional research and legal analysis would need to be undertaken to identify the federal policies and state laws that would need revision to facilitate regional tolling, particularly for existing interstate highways and state facilities not contemplated for tolling.

- **Complete In-Depth Financial Analysis.** Regional toll revenues may need to support broadly reaching, complex capital projects, which would necessitate a systematic financial analysis in order to identify the true leveraging capacity of annual toll revenues. Construction of several "mega-projects" will require more than several years, and toll revenues would not likely be fully available for debt service until the majority of network improvements were complete. For this reason, the financial capacity of the toll revenue stream may require other funding sources and financial tools to bring more funding "up front" and in line with construction expenditures.